Survival and Growth of Planted and Direct-Seeded Cherrybark Oak in South Carolina

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ABSTRACT. *Five treatments were used to evaluate the survival and growth of planted 2-0 cherrybark oak (*Quercus pagoda *Raf.) seedlings and seedlings grown from direct-seeded acorns of cherrybark oak. The treatments included: (1) deep-planted, top-pruned, (2) deep-planted, not top-pruned, (3) shallow-planted, top-pruned, (4) shallow-planted, not top-pruned, and (5) acorns direct-seeded. Survival was not affected by treatments. Planting depth and pruning did not affect survival of planted seedlings. The root collar of seedlings was placed about 1 ft below the groundline in the deep-planted treatments; however, after 5 yr these seedlings had survived as well as those in the shallow-planting treatments where the root collar was set at or near the groundline. Seedlings from the direct-seeded acorns were significantly smaller after 5 yr than planted seedlings. There were no differences in the size of seedlings in the planting treatments. Seedlings were 1.0 to 1.5 ft shorter when pruned after planting than the unpruned seedlings and grew more in height during the 5 yr period than the unpruned seedlings. South. J. Appl. For. 20(4):194–196.*

Public and private programs to reforest former agricultural land have stimulated interest in artificial regeneration of bottomland hardwoods. Oak species have been favored, due to their potential value for lumber and wildlife (Allen 1990). Intensively cultured plantations, however, are expensive to establish (Bullard et al. 1991). Direct-seeding has proven successful for heavy-seeded species such as oaks (Johnson and Krinard 1987, Kennedy 1993, Wittwer 1991). Besides ease of handling, direct-seeding has the advantage of being less expensive than planting bareroot seedlings. In operational practice, there have been numerous failures of direct-seeding (R. Simmering, pers. comm., 1993). Moreover, the initial height advantage of planted seedlings means the landowner using direct-seeding has to accept smaller trees, at least early in the rotation. Nevertheless, there have been few direct comparisons of planting and direct-seeding on the same site.

This study was designed to test another method for establishing oak regeneration, planting large 2-0 seedlings, and to compare survival and growth to direct-seeded seedlings. Planting larger seedlings is potentially advantageous because fewer seedlings would need to be planted to fully occupy the site, and they may require less intensive site preparation and weed control treatments. Potential disadvantages include the higher cost of raising 2-0 stock; difficulty in handling and transporting larger stock; and the larger planting hole necessary. Some of the handling problems could be alleviated by top-pruning the seedlings (Johnson et al. 1986).

Five treatments were used to evaluate the survival and growth of 2-0 cherrybark oak seedlings planted at two depths, with and without top-pruning, and seedlings grown from direct-seeded acorns of cherrybark oak.

Methods

Study Site

This study was established in the floodplain of the Santee River, about 20 miles southeast of Manning, SC. In late 1982, a 60 ac forested area was clearcut, debris removed, and the cleared area was root-raked. The study was established in March, 1983. Soils are of the Tawcaw series of fine, kaolinitic, thermic Fluvaquentic Dystrochepts. These soils have dark brown silty clay A horizons over brownish clayey and loamy B horizons. Drainage is poor, and runoff and permeability are slow. Many areas are frequently flooded, and the water table ranges between 20 and 48 in. during winter and early spring. Species recommended by the USDA Soil Conservation Service for planting are cottonwood (*Populus*

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deltoides Bartr. ex Marsh.), loblolly pine (*Pinus taeda* L.), sycamore (*Platanus occidentalis* L.), sweetgum (*Liquidambar styraciflua* L.), water oak (*Q. nigra* L.), and cherrybark oak. Site index is 90 to 100 ft at base age 50 for water oak, cherrybark oak, and willow oak (*Q. phellos* L.).

Design and Treatments

The study was designed as a randomized complete block with five replications of five treatments. Blocks were approximately 60 ft by 100 ft in size. Each block contained six rows; rows were 10 ft apart. One of five treatments was randomly assigned to each row in each block. Planting spots within rows were 5 ft apart, thus a spacing of 5 ft by 10 ft. A sixth row was direct-seeded with Shumard oak (*Q. shumardii* Buckl.) but these results are not presented.

Treatments were as follows:

1. 2-0 cherrybark oak, deep-planted, not top-pruned (D_{NP})
2. 2-0 cherrybark oak, deep-planted, top-pruned (D_P)
3. 2-0 cherrybark oak, shallow-planted, not top-pruned (S_{NP})
4. 2-0 cherrybark oak, shallow-planted, top-pruned (S_P)
5. Cherrybark oak acorns, direct-seeded (DS).

Seeds for all treatments were collected near Stoneville, MS. Seedlings were grown in the nursery at the Southern Hardwoods Laboratory at Stoneville, MS.

Planting and Pruning

Seedlings were planted in 9 in. diameter holes dug with a gasoline-powered posthole digger. Holes for deep-planted seedlings were approximately 2 ft deep, and those for shallow-planted seedlings were approximately 1 ft deep. The root systems of seedlings were pruned to about 9 in. in width and 1 ft in length before planting. Root collars of deep-planted seedlings were planted about 1 ft below the groundline, and at groundline for the shallow-planted seedlings. Top-pruned seedlings were pruned 1 ft above the groundline after planting. Unpruned seedlings averaged 2 to 2.5 ft tall at planting. Soil was replaced and tamped firmly around the roots. Four acorns per spot in direct-seeded rows were sown 1 to 2 in. deep. There were 20 seedlings or direct-seeded spots in each row. No weed control was done after planting.

Measurements

Height and survival were measured after the first and fifth growing seasons, and diameter at breast height (dbh) after the fifth growing season. Diameter was measured to the nearest 0.1 in. at 4.5 ft aboveground (dbh) when a tree was tall enough. Height was measured with a graduated aluminum pole to the nearest 0.1 ft. The four acorns planted at each direct-seeded spot were considered as one planting spot. If more than one acorn germinated, the height and diameter of the largest seedling were used in statistical analysis.

Statistical Analyses

The mean of each block by treatment combination was considered the experimental unit. Mean survival (arc-sine transformed), dbh, and total height of the seedlings in each treatment were tested at the 0.05 level of confidence. Means were compared using Duncan's New Multiple Range Test.

Results and Discussion

Mean survival, dbh, and total accumulated height for planted and direct-seeded cherrybark oak are shown in Table 1. Analysis of variance showed no significant difference in survival due to treatment after 1 or 5 yr. There were no differences in survival between deep- and shallow-planted seedlings.

There were significant differences in seedling size among treatments at 1 and at age 5. Direct-seeded cherrybark oaks were significantly smaller than planted seedlings in height after 1 and 5 yr, and in dbh after 5 yr (Table 1). At age 5, seedlings from direct-seeded acorns were about 50% as large as planted seedlings. Significant differences in height at age 1 were caused by pruning and deep planting, with the shallow-planted, unpruned seedlings significantly taller than the other planted seedlings. Seedlings were 2 to 2.5 ft tall before pruning, thus 1 ft to 1.5 ft of top material was removed by pruning. By age 5, there were no significant differences in height or dbh among planted seedlings, regardless of depth of planting

Table 1. Average survival, dbh, and total height of planted 2-0 and direct-seeded cherrybark oak after one and five growing seasons.[1]

	Survival[2]		Height		
Treatment	Yr 1	Yr 2	Yr 1	Yr 2	Diameter (in.)
	(%)		(ft)		
Deep, not pruned[3]	84a	76a	1.9b	7.8a	0.8a
Deep, pruned[4]	61a	54a	1.6b	7.7a	0.7a
Shallow, not pruned[5]	72a	64a	2.3a	7.6a	0.7a
Shallow, pruned	69a	69a	1.8b	7.5a	0.9a
Direct-seeded	78a	78a	0.6c	3.8b	0.3b

[1] Values in a column followed by the same letter are not significantly different at the 0.05 level.
[2] Mean of 5 replications, with 20 seedlings or direct-seeded spots per row.
[3] Deep planting means planting holes 2 ft deep, with root collar approximately 1 ft below groundline.
[4] Seedling top-pruned 1 ft above groundline after planting.
[5] Shallow planting means planting holes 1 ft deep, with root collar at or slightly below groundline.

or whether seedlings were top-pruned. Pruned seedlings actually grew more in height during the 5 yr period than the unpruned seedlings. At age 5, the study area was infested with briars, but most oak seedlings appeared to be in a free-to-grow situation.

Conclusions

Direct-seeding can be as effective as planting seedlings. There were no significant differences in survival between treatments. Survival rates of 60% to 80% are high for direct seeding, compared to operational rates which are typically around 35% (Kennedy 1993). This was due in part to our use of "spot" survival estimates, where survival was based on four acorns at a sowing spot, rather than one, which is common in operational direct-seeding. It also may have been due to the relatively intense site preparation which probably removed or set back common woody and herbaceous competitors, and reduced habitat for small mammals that prey on acorns (Johnson and Krinard 1987).

Stand establishment is faster with planted seedlings. Initial differences in height were maintained up to 5 yr; planted seedlings were twice the size of seedlings from direct-seeded acorns. These results follow the same trends in size difference reported by others (Allen 1990, Wittwer 1991).

Large (2-0) seedlings can be planted with root collars as much as 1 ft below groundline without affecting survival or growth. Large seedlings can be top-pruned without reducing survival and will actually grow more vigorously than unpruned seedlings. Thus, it may be possible to reduce shipping and handling expense by top-pruning (Johnson et al. 1986). In this study, however, top-pruning occurred after the seedling was planted. Pruning before outplanting may affect vigor in ways not tested in this study.

Literature Cited

ALLEN, J.A. 1990. Establishment of bottomland oak plantations on the Yazoo National Wildlife Refuge Complex. South. J. Appl. For. 14:206–210.

BULLARD, S., J.D. HODGES, R.L. JOHNSON, AND T.J. STRAKA. 1991. Economics of direct seeding and planting for establishing oak stands on old-field sites in the South. South. J. Appl. For. 16:34–40.

JOHNSON, P.S., C.D. DALE, K.R. DAVIDSON, AND J.R. LAW. 1986. Planting northern red oak in the Missouri Ozarks: A prescription. North. J. Appl. For. 3:66–68.

JOHNSON, R.L., AND R.M. KRINARD. 1987. Direct-seeding of southern oaks—a progress report. P. 10–16 *in* Proc. of 15th Annu. Hardwood Symp. of the Hardwood Res. Counc.

KENNEDY, H.E., JR. 1993. Artificial regeneration of bottomland oaks. P. 241–249 *in* Oak Regeneration: Serious Problems, Practical Recommendations, Loftis, D.L., and C.E. McGee (eds.). USDA For. Serv. Gen. Tech Rep. SE-84.

WITTWER, R.F. 1991. Direct-seeding of bottomland oaks in Oklahoma. South. J. App. For. 15:17–22.